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(19) (CA) APPLICATION FOR CANADIAN PATENT (12)

(54) Acoustic Net Alarm

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Notice: This application is as filed and may therefore contain an incomplete specification.

ACOUSTIC NET ALARM

Abstract

The invention relates to an acoustic alarm for acoustically enhancing fishing gear. The present alarm is an electromechanical device which when submerged in water produces acoustic vibrations containing frequencies which can easily be detected by non-target species, in particular, cetaceans. Attachment of one or more acoustic net alarms to the fishing gear serves to enhance a net acoustically so that cetaceans are alerted to its presence. The device generates a distinct, reproducible acoustic signal at specified time intervals preferably using an electronically controlled, battery-powered solenoid switch. When energized, the solenoid switch causes an actuator to strike the wall of a sealed resonant tube which is enclosed by a hollow spherical casing. Mechanical vibrations are transmitted directly to the spherical casing at the top and bottom of the device where the perimeter of the tube is connected to the casing. When the spherical casing vibrates, it transmits an omnidirectional acoustic signal into the water where it may be detected by cetaceans at a distance.

ACOUSTIC NET ALARM

Field of the Invention

This invention relates to a problem of incidental entrapment of non-target species in fishing gear and, more specifically, to a device designed to attach to fixed fishing gear in order to enhance it acoustically. Cetaceans, other marine mammals, and non-target species are alerted to the presence of enhanced fishing gear, preventing the creatures from becoming accidentally entrapped.

Background of the Invention

Incidental entrapment of non-target species such as whales, sharks or dolphins in fixed fishing gear is a problem of increasing concern to the fishing industry. This problem not only causes considerable monetary losses, but such by-catch may also seriously affect populations of these creatures.

Collisions of cetaceans with fixed fishing gear appear to be due to the failure of the animals to detect the presence of the net in time to avoid it. Studies have shown that humpback whales can navigate successfully through netted areas at night without using any form of echolocation. It is also generally believed that visual cues are not used by the animals to navigate. These studies have lead to experiments which measure the acoustic emissions from fishing nets. The experimental results suggest that it is these acoustic emissions as well as other acoustic emissions from the environment which are used by the animals to navigate (J. Lien; S. Todd; and J. Guigné, "Inferences About Perception in Large

Cetaceans, Especially Humpback Whales, From Incidental Catches in Fixed Fishing Gear, Enhancement of Nets by 'Alarm' Devices, and the Acoustics of Fishing Gear", *Sensory Abilities of Cetaceans*, 1990).

Prior Art

A pilot test of devices used to enhance fishing gear acoustically took place in 1979. These devices actively emitted acoustic signals which contained a range of frequencies. The devices included high frequency electronic pingers (27 to 50 kHz), low frequency electronic beepers (3.5 kHz) and low frequency mechanical clangers (500 Hz to 1 kHz).

FIGS. 5, 6, and 7 are sketches of the physical embodiments of three such prior art devices. The first, FIG. 5 is a mechanical "clanger" which emits low frequency acoustics on the order of 500 Hz to 1 kHz. These mechanical clangers are actuated by wave action. The clanger comprises two floats 48a,48b which are attached by ropes 46a,46b to an anvil 50 and a striker 52, respectively. Both the anvil 50 and the striker 52 are located underwater. The striker 52 is slidable relative to the anvil 50 along a rod 54 which is attached to the anvil. The floats 48a,48b oscillate generally independently under the influence of surface waves, thereby causing the striker 52 to impact intermittently with the anvil 50 and thus producing an acoustic signal which is transmitted into the surrounding water. The clangers tend to be ineffective because it is difficult to adjust properly the length of the ropes 46a,46b connected to the floats 48a,48b which operate these alarms. Other problems associated with this device are that it can become entangled in the fishing gear and cease to operate and that it is inoperative in relatively calm water.

A second type of prior art device, depicted in FIG. 6, is known as a "beeper". This device produces relatively low frequency acoustic signals (3.5 kHz) using a battery-powered , electrically activated diaphragm encased in a watertight plastic tube. The diaphragm vibrates, causing acoustic waves to travel through the air inside the tube to the tube wall, in turn causing the tube to vibrate and send acoustic waves into the water surrounding the tube. Although this type of alarm tends to reduce the probability of collisions, the acoustic signals are not emitted in an omnidirectional manner and the magnitude of the acoustic output is relatively low.

FIG. 7 shows a third type of prior art device which is known as a "pinger". The pinger emits a high frequency, broadband acoustic output (27 to 50 kHz) using a battery-powered, electronically excited ceramic crystal. Since attenuation increases with frequency for acoustic waves travelling in sea water, the signals produced by the pinger are quickly attenuated. Results showed that these pinger devices did not reduce the probability of a collision, but damage to fishing gear which employed these devices was less severe than that experienced by nets which did not employ any warning devices. Cetacean collisions with these nets were of the type where the animals were manoeuvring to avoid the nets but were unsuccessful. Collisions of this type are generally less severe and are believed to be due to the failure of cetaceans to detect the low amplitude output of the pinger in time to avoid the fishing gear.

The results of these tests proved that acoustic enhancement of fishing gear lowered the probability of collisions between the cetaceans and gear. Fishing gear with low frequency beepers attached was less likely to incur a collision compared to fishing gear without any type of acoustic enhancement. When collisions did

occur damage to fishing gear with beepers was less severe. Mechanical clangers did not reduce the incidence of collisions because they frequently became entangled in the fishing gear and ceased to operate properly. High frequency pingers did not lower the probability of collisions, however the damage was less extensive. The damage was caused by the animals manoeuvring unsuccessfully to avoid collision because the acoustic signal emitted from the pinger was not loud enough to be detected by the animals in time for them to execute successful evasive action.

Other prior art devices have been found which were designed to actively emit acoustic waves into water to prevent the entanglement of Dall's porpoise (phocoenoides Dalli) in the Japanese salmon gillnet fishery (Hatakeyama, Y. 1986, Test Of New Type Sound Generators, Fisheries Agency of Japan, Tokyo.) The total number of Dall's porpoises to be taken in a year was fixed by U.S. law from 1981 to 1987. Hence the Japanese fishermen were virtually obligated to develop and use techniques to reduce the incidental catch in the gillnets. Tests of four types of sound generators were conducted from 1981 to 1989.

The initial sound generator, coined SG-1, produced an acoustic output of 9.0 kHz based on the whistle of the bottlenose dolphin. The SG-1 was powered by four 1.5 volt dry cell batteries which were housed along with its electronic circuitry in a plastic case, with dimensions 83 mm diameter and 406 mm length. This type of device was tested on gillnets from 1981 to 1984, at which point the testing was abandoned due to frequent breakage, unsatisfactory reduction in the entanglement compared to other devices, and complications associated with its attachment to nets and retrieval.

The physical embodiment of the three other sound generators is as shown in the sketches of Figs. 8a and 8b. These sound generators were powered by two

sealed lead storage 12 volt batteries connected in series. The batteries must be charged for 12 hours after the sound generator has been in use for 12 hours. The electronic circuit 56, the batteries 58, and the transmitter 60 were housed in a radio buoy 62 having a maximum diameter of 380 mm and a height of 797 mm and attaining an overall weight of 20 kg.

The acoustic outputs of the SG-2 and SG-3, both developed in 1983, were based on the frequency components of clicks emitted by Dall's porpoise. The SG-2's output consisted of 145 kHz pulses repeated within a constant period. The SG-3 emitted 135 to 150 kHz pulses similar to those used in the echolocation of Dall's porpoise. These sound generators were tested on gillnets from 1983 to 1986; however, the decrease in entanglement was less than expected.

The SG-4 was developed to emit random pulses and Frequency Modulation (FM) waves ranging between 20 to 50 kHz. The signals were determined to have alarming effects on Dall's porpoise during acoustic experiments conducted during 1984. Testing of the SG-4 on gillnets was conducted from 1985 to 1989. A concentration of entanglement was observed in the portion of the net where the signal from the SG-4 was the weakest.

SUMMARY OF THE INVENTION

It is an object of the invention to provide an alarm for acoustically enhancing fishing gear which overcomes the aforementioned disadvantages and drawbacks of the prior art devices.

It is another object of this invention to provide an active acoustic alarm which, when attached to fixed fishing gear, alerts non-target species and, in particular cetaceans, to the presence of the gear.

It is a further object of this invention to provide an alarm which emits acoustic signals of an amplitude and frequency that are not readily attenuated in seawater.

It is another object of the invention to provide an alarm which emits acoustic signals which have a dominant frequency content which is well within the hearing range of cetaceans, but not the hearing range of target species.

It is yet another object of the invention to provide a device for the acoustical enhancement of fixed fishing gear which may be easily manufactured and which can be mass produced at relatively low cost.

It is a further object of this invention to provide an acoustic alarm which is both robust, durable and easy to deploy, and which has a very low power consumption rate in order to maximize power source life.

Accordingly, there is provided a device for the acoustical enhancement of fixed ocean fishing gear for the prevention of collisions of non-target species therewith which comprises a resonant tube, means disposed within the resonant tube for selectively causing the tube to be vibrated, and a substantially spherical, hollow casing. The term "resonant tube" refers generally to a tube which is free to vibrate, or resonate at its natural frequencies, especially when the tube is struck with an impact blow. The resonant tube is disposed generally diametrically within the casing and is rigidly attached to the casing so as to form a watertight chamber therebetween. Vibrations from the resonant tube are transmitted to the casing for subsequent substantially omnidirectional retransmission by the casing as acoustic signals.

Preferably, the tube is vibrated in a consistent and repetitive manner such that the device emits a distinct, reproducible acoustic signal at a specified time

interval. The output signals are within the hearing range of at least a select group of non-target species but are negligible over the hearing range of the target species. It is thought that upon encountering the signals produced by these alarms on a net, cetaceans will be both curious and wary, approaching cautiously and discovering the net without becoming entangled. After the initial encounter with the alarms, cetaceans will associate the acoustic signal with the presence of a net and stay away.

The spherically-enclosed resonant tube design results in the omnidirectional nature of the acoustic output of the alarm. The acoustic signal is preferably produced when an electronically-controlled, battery-powered solenoid switch is energized, causing an actuator to strike the wall of the enclosed resonant tube. Preferably, the solenoid switch is controlled by means of an electronic timing circuit with a duty cycle optimized for longevity of power supply as well as consistency and reproducibility of the acoustic signal. A seawater switch may be employed so that power to the timing circuit is only supplied when the device is immersed in seawater. Low power electronics may also be employed to further extend the nominal battery life.

The vibration of the tube which results from the impact of the solenoid actuator is efficiently transmitted directly to the spherical enclosure via the connection of the tube at its periphery to the top and bottom of the casing. The spherical shape of the casing causes acoustic waves to be emitted in all directions when it vibrates.

Further features and advantages will become apparent from the following description of the invention with reference to the drawings attached hereto.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of the invention indicating the cutting planes of the sectional views of FIGS. 2 and 3.

FIG. 2 is a partial cross-sectional elevation of the invention shown along lines A-A of FIG. 1.

FIG. 3 is a partial cross-sectional elevation of the invention, similar to FIG. 2, but shown along lines B-B of FIG. 1.

FIG. 4 is a schematic diagram of the electronic circuitry of the invention.

FIGS. 5, 6, 7 and 8(a and b) are sketches of prior art devices illustrating a mechanical clanger, a beeper, a pinger, and a high frequency sound generator, respectively.

DESCRIPTION OF THE PREFERRED EMBODIMENT

With reference to the drawings, FIGS. 1, 2 and 3 illustrate a prototype of the device comprising a substantially spherical, 8.0" diameter, hollow outer casing 10 of 0.125" wall thickness having a round cylindrical, 4.0" diameter resonant tube 12 of 0.25" wall thickness disposed generally diametrically therein. The perimeter of the tube 12 is rigidly attached to the casing 10, such as by welding, at its top end 12a and near its lower end at 12b so that vibrations from the tube 12 are readily transmitted to the casing 10 for subsequent retransmission therefrom. This attachment forms a watertight chamber 13 surrounding the tube 12 and within the casing 10, the purpose of which will be described in greater detail hereinbelow.

The components for causing the tube 12 to be selectively vibrated are preferably housed within the resonant tube 12. In the preferred embodiment, an actuator 42 is driven by means of a solenoid switch 32 to impact the wall of the resonant tube 12 with considerable force, thereby causing it to vibrate. The solenoid switch 32 is controlled by a timing circuit (see FIG. 4) which is integrated into a circuit board 30 with power being supplied thereto by a battery 28.

The resonant tube 12 extends outwardly of the casing 10 at its lower end 12c where it is provided with a flange 14 to which a cover 16 is attachable by means of bolts 22. The cover 16 facilitates closure and sealing of the tube 12 and permits easy access for repair and/or replacement of the operational components contained within the tube 12. Seal means is provided between the cover 16 and the flange 14 to prevent water from entering the device. As shown in FIGS. 2 and 3, an O-ring 18 is disposed within an annular groove 20 provided in flange 14. The O-ring 18 is compressed when the cover 16 is attached to the flange 14 with bolts 22, providing an effective seal.

While the resultant enclosed resonant tube structure is relatively strong and should withstand considerable abuse, one or more integral strengthening ribs 45 may be provided laterally around the casing 10 in order to provide additional strength. To facilitate attachment to fishing gear, a protrusion 25 may be provided at the top of the casing 10 having a pair of mounting holes 24 therein to allow easy attachment, such as by tethering, to a net.

The casing 10 facilitates the very efficient conversion of the mechanical energy of the actuator-tube impact to the omnidirectional acoustic energy emitted into the seawater medium. Preferably, the resonant tube and chamber contain air. This permits the tube 12 to vibrate relatively freely when struck by the actuator 42.

The frequency and amplitude of the vibration is greater than if the tube 12 were surrounded by seawater (i.e. with no casing provided). Seawater would dampen the vibration of the tube 12, reducing its amplitude and, therefore, the power of the acoustic signal transmitted into the seawater medium. The damping effect of the seawater would also flatten the frequency response of the transmitted signal compared to that produced by the enclosed resonant tube.

Once the vibration has been produced in the tube 12 by the actuator 42, it is transmitted directly to the casing 10. In addition, standing acoustic waves are set up in the air inside the tube and in the surrounding chamber 13, which are also transmitted to the casing 10. The air in the chamber 13 also serves as a reflector, directing most of the acoustic energy of the vibrating spherical casing 10 into the water. This is because the acoustic impedance of air is much greater than that of seawater; the mismatched impedance makes the air medium reflective in relation to the seawater.

It will be appreciated that various gases may be employed as the medium within the chamber, although air is preferred since no specialized equipment and processes, which tend to increase production costs, are required.

A mounting frame 26 is employed to position accurately the battery 28, controller circuit board 30, and solenoid switch 32 within the confined space of the resonant tube 12 and to prevent these components from contacting the walls of the tube. Preferably, the mounting frame 26 comprises a base 27 having opposed member pairs 27a, 27b extending downwardly therefrom. The member pairs 27a, 27b are designed to accommodate the circuit board 30 and the battery 28 therebetween. One of the member pairs 27a is provided with radially outwardly extending feet 29 which are engageable with an annular shoulder 21 formed in the

flange 14 to anchor the mounting frame 26 securely within the resonant tube 12 when the cover 16 is attached. Each of the feet 29 are secured to the shoulder 21 using screws or the like (not shown). A spacer 34 compresses the battery terminals 36 against the circuit board contacts, not shown, when the cover 16 is bolted to the flange 14. The spacer 34 and/or the battery terminals 36 may be resilient to provide sufficient biasing force to maintain the terminals 36 in contact with the respective circuit board contacts.

The solenoid switch 32 is attached to the base 27 of the mounting frame 26 by means of a yoke 31. The yoke 31 has a pair of opposed upstanding arms 31a, 31b having holes 33 disposed therein through which the actuator 42 is propelled to impact the wall of the tube 12. A spring 44 may be provided, for example, between the yoke arm 31a and a fixed flange 35 on the actuator 42, to return the actuator 42 after impact to its original, i.e. rest, position.

The electronic controller circuit board 30 controls the two circuits of the alarm (see FIG. 4). When the alarm is immersed in the ocean, a seawater switch circuit detects an electric current flow through the conductive seawater medium between two electrodes. The cathode is preferably an insulated brass screw 40 mounted in the exposed portion 12c of the tube 12, while the grounded casing serves as the anode. When a current is detected, a relay is closed, and power is supplied to the timing circuit. When the alarm is removed from the seawater, the current flow between the electrodes ceases, the relay opens and the timing circuit is deactivated. The timing circuit distributes power to the solenoid switch 32, controlling the duty cycle (the length of time the switch is energized) and the interval between duty cycles. During the duty cycle, the energized coil of the solenoid switch 32 exerts an electromagnetic force on the actuator 42. This propels

the actuator 42, causing it to impact with the tube wall 12. At the end of the duty cycle, the spring 44 returns the actuator to its original position until the next duty cycle. The power supply is preferably a 6-volt lantern battery 28, or equivalent. The controller circuit board 30 is optimized to achieve the longest possible battery life while providing an intense, reproducible acoustic output.

Although the alarm is watertight when sealed, the circuit board 30 may be encapsulated in an epoxy resin to prevent possible damage due to water leakage or other abuse when the alarm is opened to change the battery. Changing the battery 28 involves simply removing the bolts 22 which hold the cover 16 in place, removing the spent battery, inserting a fresh battery and then replacing the cover 16 and bolts 22.

It will be appreciated that various factors may influence the frequency and/or intensity of the resultant acoustical signals. Such factors include, but are not limited to: dimensions and proportions of the various components; materials selection; choice of medium within chamber; inclusion of additional elements such as the net attachment protrusion 25 at the top of the device or strengthening ribs 45, etc.; and the quality of the connection/weld between the resonant tube 12 and the surrounding casing 10. Preferably, both the resonant tube 12 and the casing 10 are made from aluminum. However, any material which exhibits good resistance to corrosion in seawater, can be welded and/or cast relatively easily and has good acoustical vibration transmittability, can be used.

The simple design of the acoustic net alarm lends itself to being mass produced at relatively low cost. Durability was also a factor in the alarm design. The thick, preferably aluminum construction of the casing will withstand considerable abuse. To prevent damage due to water leakage or mechanical abuse,

the circuit board, as explained above, may be encapsulated in epoxy resin. The mounting frame prevents any motion of the battery, circuit board or solenoid switch within the alarm, reducing the possibility of mechanical damage due to rough handling of the alarm. The assembled alarm is buoyant, and thus will not sink if it becomes detached from the net.

The distinct peak amplitude frequency of the acoustic signal which is emitted by the device is ideal because it is unnatural to the environment of marine mammals. In the case of the prototype, the peak amplitude frequency of about 5.0 kHz is well within the hearing range of marine mammals, humpback whales in particular. The signal amplitude is, however, negligible within the hearing frequency range of typical target species such as codfish. Other characteristics of the acoustic signal are that it is reproducible (i.e. the same signal is produced each time the actuator hits the tube) and that it is consistent (i.e. the time interval between signals is constant).

In use, a plurality of such alarms are disposed underwater in the vicinity of the fishing gear, preferably attached to the nets at a predetermined depth. Immersion in the water activates the alarms which then commence production of the acoustic signals as described above. It is thought that upon encountering the signals produced by these alarms on a net, cetaceans will be both curious and wary, approaching cautiously and discovering the net without becoming entangled. After the initial encounter with the alarms, cetaceans will associate the acoustic signal with the presence of a net and stay away.

While there has been described above the preferred embodiment of the invention, it is envisioned that a device without the spherical enclosure could be used to effectively alert cetaceans to the presence of fishing gear in their vicinity.

In such an embodiment, the impacting mechanism, battery and associated circuitry (essentially the same as described above) would be hermetically sealed within the resonant tube. While such a device may not necessarily exhibit the same quality of signal as the aforedescribed spherically enclosed design in terms of directionality, frequency or amplitude, these factors can compensated with the appropriate modifications if the consequences of such modifications are acceptable. For example, since a typical set up would include several devices, the devices could be arranged easily at angles to one another so as to provide the desired directional transmission. Power could be boosted and dimensional criteria selected so as to produce similar acoustic output which would alarm cetaceans in the aforementioned manner.

While there has been described herein particular embodiments of the inventive device, it is to be understood that various modifications may be made thereto without departing from the spirit and scope of the invention as defined in the preceding disclosure and the following claims.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A device for the acoustical enhancement of fixed ocean fishing gear for the prevention of collisions of non-target species therewith, comprising:

a resonant tube;

means disposed within said resonant tube for selectively causing said resonant tube to be vibrated; and

a substantially spherical and hollow casing, said resonant tube being disposed generally diametrically within said casing and being rigidly attached to said casing so as to form a watertight chamber therebetween, whereby vibrations from said tube are transmitted to said casing for subsequent substantially omnidirectional retransmission by said casing as acoustic signals.

2. The device as claimed in claim 1, wherein said means for causing the resonant tube to be vibrated vibrates said resonant tube intermittently at predetermined intervals.

3. The device as claimed in claim 1, wherein said acoustic signals are within the hearing range of said non-target species but are negligible over the hearing range of a target species.

4. The device as claimed in claim 3, wherein said acoustic signals have a dominant frequency of about 5 kHz.

5. The device as claimed in claim 1, wherein the vibration of said resonant tube further produces standing acoustic waves which are transmitted to said casing through a medium within said chamber.

6. The device as claimed in claim 5, wherein said medium has a greater acoustic impedance than that of seawater.

7. The device as claimed in claim 6, wherein said medium is air.

8. The device as claimed in claim 1, wherein said means for selectively causing said resonant tube to vibrate comprises:

an actuator;

a driving means associated with said actuator for causing said actuator to impact with said resonant tube; and

control means for controlling said driving means.

9. The device as claimed in claim 8 wherein said driving means is a solenoid switch.

10. The device as claimed in claim 9, wherein said actuator is normally biased in a spaced-apart relationship with said resonant tube by a spring means.

11. The device as claimed in claim 10, wherein said control means comprises a timing circuit and means for supplying power thereto.

12. The device as claimed in claim 11, wherein said timing circuit controls:

the power to said solenoid switch;

a duty cycle; and

the interval between duty cycles.

13. The device as claimed in claim 12, wherein said means for supplying power to said timing circuit comprises:

a power source;

a relay operable between open and closed positions whereby power from said power source is supplied to said timing circuit when said relay is in said closed position and power from said power source to said timing circuit is interrupted when said relay is in said open position; and

means for operating said relay between said open and closed positions.

14. The device as claimed in claim 1, further comprising means for attachment to or near said fishing gear.

15. A device for the acoustical enhancement of fixed ocean fishing gear for the prevention of collisions of non-target species therewith, comprising:

a resonant tube;

means disposed within said tube for selectively causing said tube to be vibrated;

a substantially spherical and hollow casing, said resonant tube being disposed generally diametrically within said casing and extending outwardly of said casing at one end of said tube, said tube and said casing being rigidly connected so as to form a watertight chamber therebetween, whereby vibrations from said tube are transmitted to said casing for subsequent substantially omnidirectional retransmission by said casing as acoustic signals; and

cover means for sealing said outwardly extending end of said tube.

16. The device as claimed in claim 15, wherein said means for causing the resonant tube to be vibrated vibrates said resonant tube intermittently at predetermined intervals.

17. The device as claimed in claim 15, wherein said acoustic signals are within the hearing range of said non-target species but are negligible over the hearing range of a target species.

18. The device as claimed in claim 17, wherein said acoustic signals have a dominant frequency of about 5 kHz.

19. The device as claimed in claim 15, wherein said means disposed within said tube for selectively causing said tube to be vibrated is mounted by means of a mounting frame anchored between said tube and said cover means.

20. The device as claimed in claim 16, wherein said means for selectively causing said resonant tube to vibrate comprises:

an actuator;

a driving means associated with said actuator for causing said actuator to impact with said resonant tube; and

control means for controlling said driving means.

21. The device as claimed in claim 20, wherein said driving means is a solenoid switch.

22. The device as claimed in claim 21, wherein said actuator is normally biased in a spaced-apart relationship with said resonant tube by a spring means.

23. The device as claimed in claim 22, wherein said control means comprises a timing circuit and means for supplying power thereto.

24. The device as claimed in claim 23, wherein said timing circuit controls:

the power to said solenoid switch;

a duty cycle; and

the interval between duty cycles.

25. The device as claimed in claim 24, wherein said means for supplying power to said timing circuit comprises:

a power source;

a relay operable between open and closed positions whereby power from said power source is supplied to said timing circuit when said relay is in said closed position and power from said power source to said timing circuit is interrupted when said relay is in said open position; and

means for operating said relay between said open and closed positions.

26. The device as claimed in claim 25, wherein at least said casing and tube are made from aluminum.

27. The device as claimed in claim 26, wherein said means for operating said relay comprises a seawater switch circuit operable when said device is immersed in water.

28. The device as claimed in claim 27, wherein said timing circuit is disposed on a circuit board, and said circuit board is encapsulated in epoxy resin so as to be waterproof.

29. The device as claimed in claim 28, further comprising means for attachment to or near said fishing gear.

30. The device as claimed in claim 29, wherein said attachment means comprises a protrusion extending from said casing, said protrusion having at least one hole therein for allowing a tether to be connected between said device and said fishing gear.

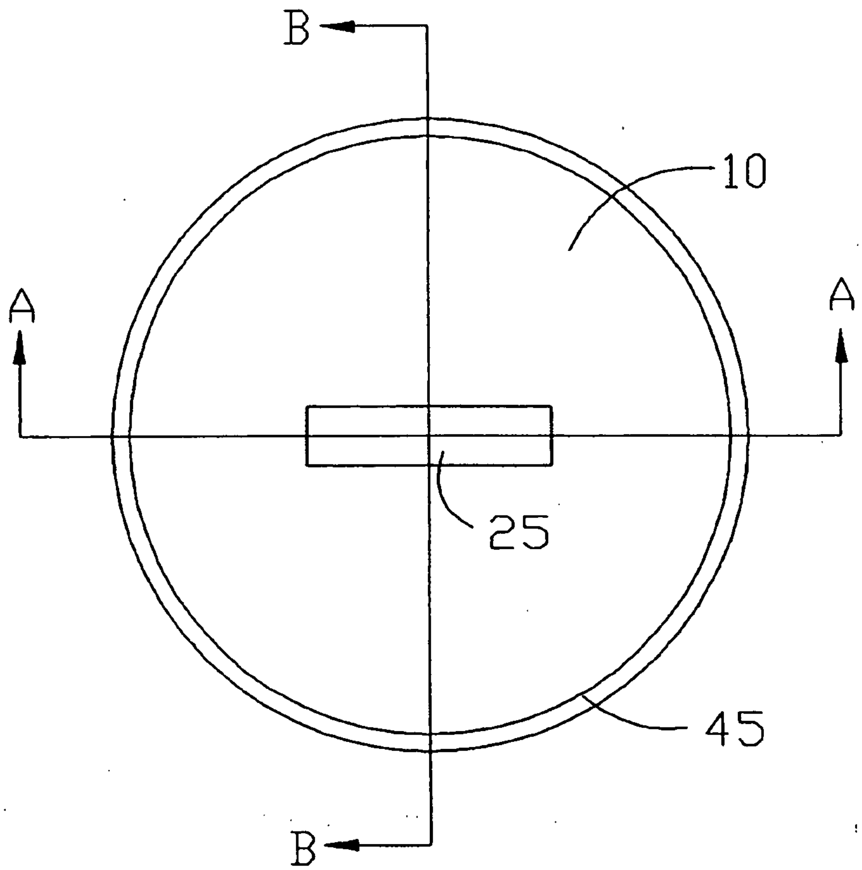

FIG. 1

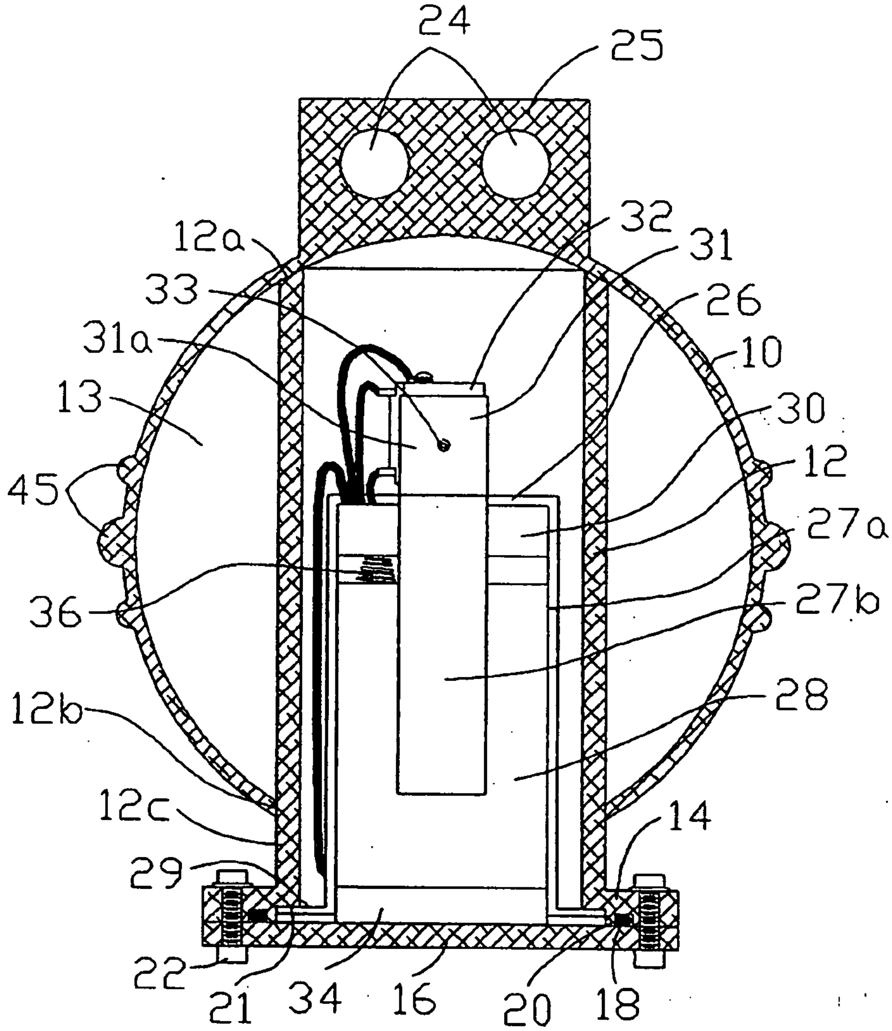

FIG. 2

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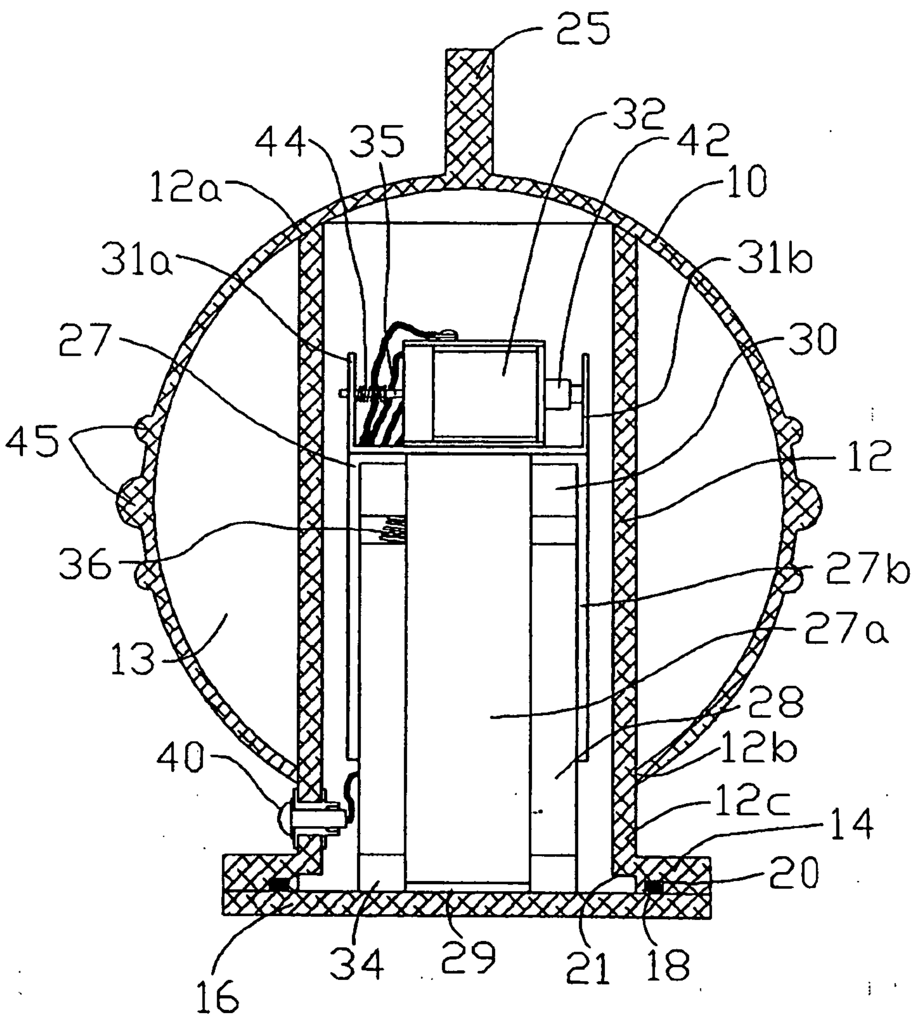

FIG. 3

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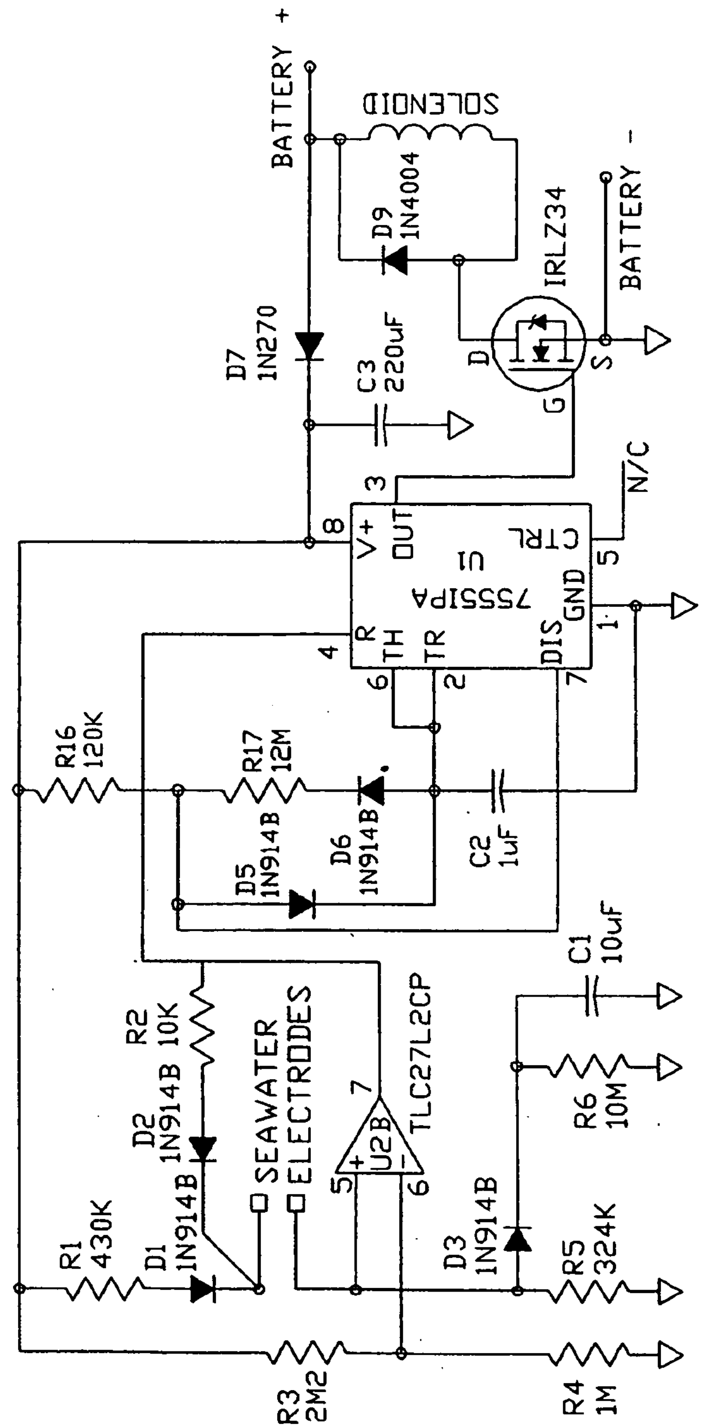

FIG. 4

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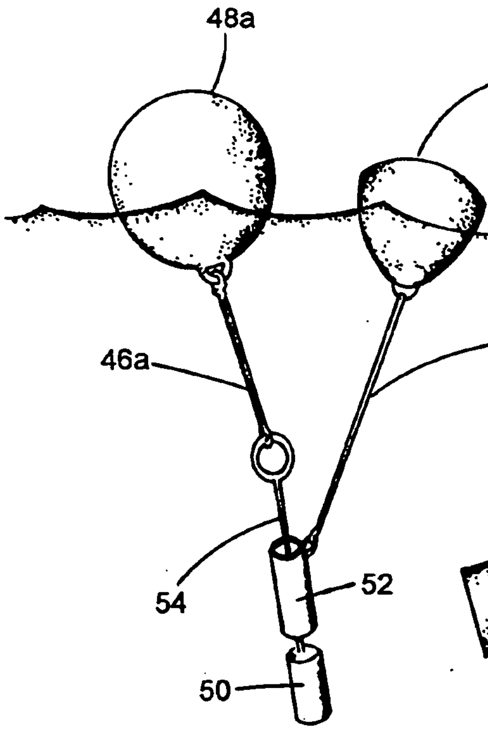

Fig. 5
PRIOR ART

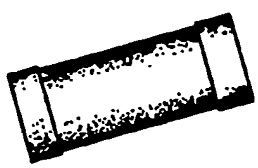

Fig. 6
PRIOR ART

Fig. 7
PRIOR ART

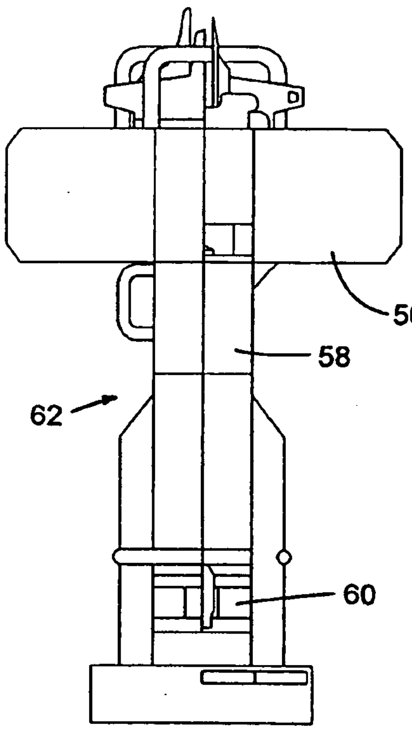

Fig. 8a
PRIOR ART

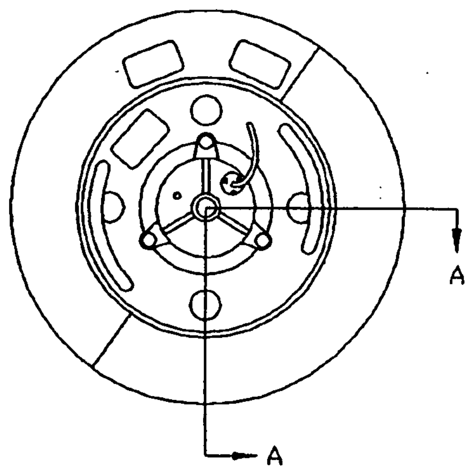

Fig. 8b
PRIOR ART

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